

LUCY: SURVEYING THE DIVERSITY OF THE TROJAN ASTEROIDS: THE FOSSILS OF PLANET FORMATION. H. F. Levison¹ and the Lucy Science team. ¹SwRI, Boulder, CO, USA (hal@boulder.swri.edu).

Mission Overview. The *Lucy* mission is the first reconnaissance of the Jupiter Trojan asteroids - objects that hold vital clues to deciphering the history of the Solar System. Due to an unusual and fortuitous orbital configuration, *Lucy*, which has been selected for further development as part of NASA's Discovery Program, will perform an exhaustive landmark investigation that visits six of these primitive asteroids, covering both the L₄ and L₅ swarms, all the known taxonomic types, and a nearly equal mass binary. It will use a suite of high-heritage remote sensing instruments to map the geology, surface color and composition, thermal and other physical properties of its targets at close range - all this within constraints of the Discovery Program. Thus, *Lucy*, like the human fossil for which it is named, will revolutionize the understanding of our origins.

Lucy's Comprehensive Tour. *Lucy* will perform flybys of six Trojans that span the diversity of the Trojan population (see **Fig. 2 on page 2**). It will launch in 2021 and will have encounters from 2025-2033.

Lucy's strengths are:

1. *High science return* – *Lucy* will visit this critical class of Solar System objects that have yet to be visited.
2. *Low risk mission* – High heritage systems.
3. *Low cost mission* – Costs fit comfortably within constraints.
4. *Timely* – Unique opportunity gets multiple high-value Trojans within Discovery scope.

Lucy also leverages multiple successful missions:

1. *Payload:* New Horizons, OSIRIS-Rex, and MGS/MER
2. *Spacecraft:* High heritage.
3. *Operations:* Experienced spacecraft (LMA), mission (GSFC), and science (SwRI) Ops Teams

High Impact Science. Through its unique tour, *Lucy* will provide crucial input to four of the ten Priority Questions for Planetary Science as expressed by the Decadal Survey in 2013 (DS13):

- What were the initial stages, conditions and processes of Solar System formation ...?
- How did the giant planets ... accrete, and is there evidence that they migrated to new orbital positions?
- What governed the accretion ..., and what roles did bombardment by large projectiles play?
- What were the sources of primordial organic matter?

The Trojan swarms contain a wide variety of small bodies, C-, D-, and P-type spectral types. Some argue they formed throughout the outer Solar System and were captured in the aftermath of giant planets migration (**Fig. 1**). Therefore, it is only by sampling their

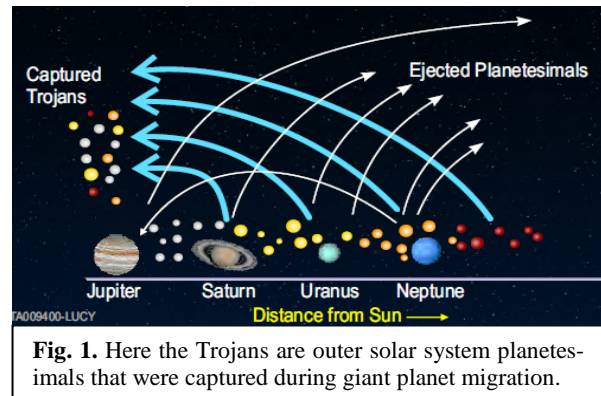


Fig. 1. Here the Trojans are outer solar system planetesimals that were captured during giant planet migration.

diversity, as *Lucy* does, that their true scientific potential can be realized.

The DS13 recommended the following “Study of these objects [Trojans] is important because they may contain key information about the parent materials that accreted in the inner Solar System. An important science goal for this decade is to begin the scientific exploration of the Trojan asteroids.”

Measurements. *Lucy's primary science objectives:*

1. *Surface composition.* *Lucy* will map the color, composition and regolith properties of the surface and determine the distribution of minerals, ices and organics species.
2. *Surface geology.* *Lucy* will map albedo, shape, crater spatial and size distributions, determine the nature of crustal structure and layering, and determine the relative ages of surface units.
3. *Interior and bulk properties.* *Lucy* will determine the masses and densities, and study subsurface composition via crater windows, fractures, ejecta blankets, and exposed bedding.
4. *Satellite and ring search.* *Lucy* will determine the number, size-frequency distribution and location of km-scale satellites and dense rings.

Conclusions. Owing to their unique location near Jupiter and the critical role they play in revealing and constraining models of the formation and evolution of the Solar System, Trojans have been a high priority for space missions for over a decade. This is evidenced by calls for their reconnaissance by spacecraft in DS13 and the 2014 NASA Science Plan. Both documents identify a survey of the diversity of Trojan asteroids among the two highest priority missions to small bodies (the other being a comet sample return). *Lucy* will accomplish the related goals of DS13 and the NASA Science Plan with a high-heritage, low-risk spacecraft and science payload - all within the Discovery Program cost cap.

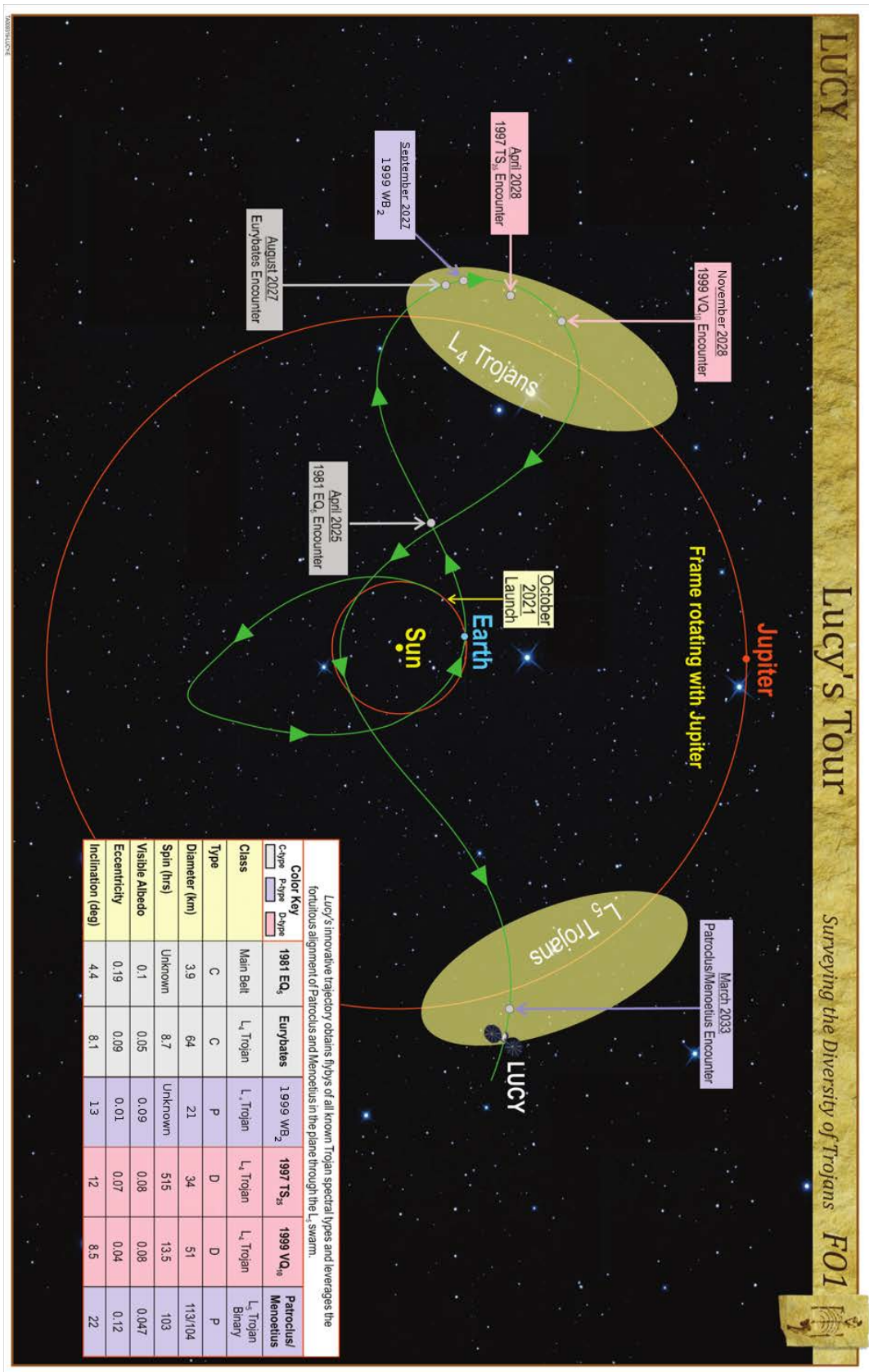


Fig. 2. Baseline mission trajectory for Lucy. Lucy will study all Trojan classes (C-, D-, and P-types) in both Trojan swarms (L₄, L₅).